(12) UK Patent Application (19) GB (11) 2 329 302 (13) A

(43) Date of A Publication 17.03.1999

(21) Application No 9810300.5

(22) Date of Filing 15.05.1998

(30) Priority Data
(31) 08927693 (32) 11.09.1997 (33) US

(51) INT CL[6]
H04L 1/12 // H04B 7/26, H04Q 7/22 7/32

(52) UK CL (Edition Q)
H4L LECX

(56) Documents Cited
GB 2322047 A EP 0353759 A2 US 5526399 A
US 4939731 A US 4710925 A US 4630126 A

(58) Field of Search
UK CL (Edition P) H4L LDGP LDGX LDLX LDSU LDSY LECX
INT CL[6] H04B 7/24 7/26, H04L 1/12, H04Q 7/22 7/32 7/38
ONLINE DATABASE: WPI

(71) Applicant(s)
US Robotics Mobile Communications Corp
(Incorporated in USA - Utah)
605 North 5600 West, Salt Lake City,
Utah 84116-0020, United States of America

(72) Inventor(s)
Scott W Rupp
John Wheeler
Brady Brown

(74) Agent and/or Address for Service
Urquhart-Dykes & Lord
8th Floor, Tower House, Merrion Way, LEEDS,
LS2 8PA, United Kingdom

(54) Abstract Title
Wireless facsimile data transmission with variable data rate

(57) A facsimile machine detects an interface with a wireless transceiver and a wireless channel for facsimile data transmission. An initial data transfer rate is established corresponding to the capability of the wireless transceiver or known channel conditions. The facsimile machine then transmits data and a receiving facsimile machine detects transmission errors and employs an automatic repeat request (ARQ) protocol for retransmission of data. When the number of repeat requests reaches a threshold a lower data rate is negotiated in order to reduce the number of repeat requests. A facsimile machine further determines when the wireless transceiver is removed and reverts back to traditional wired communication channel data rates.

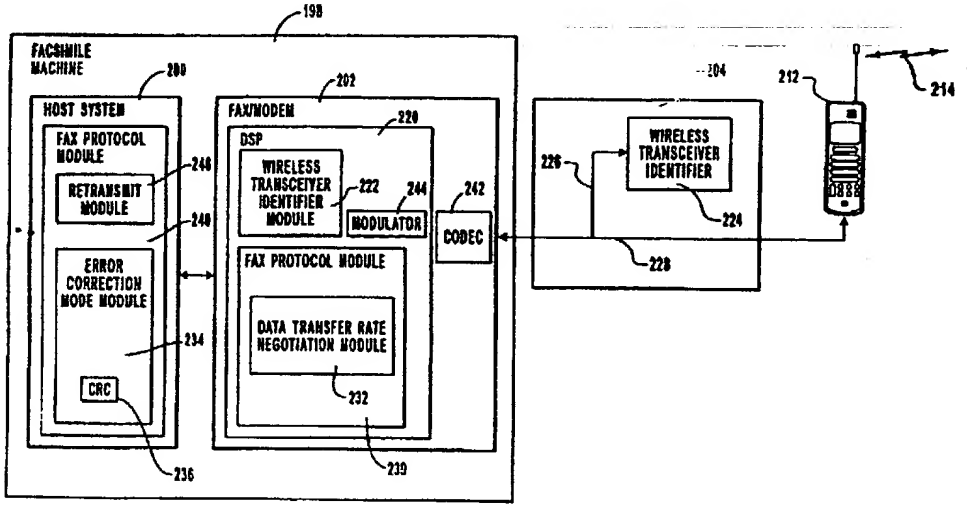


FIG. 3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

GB 2 329 302 A

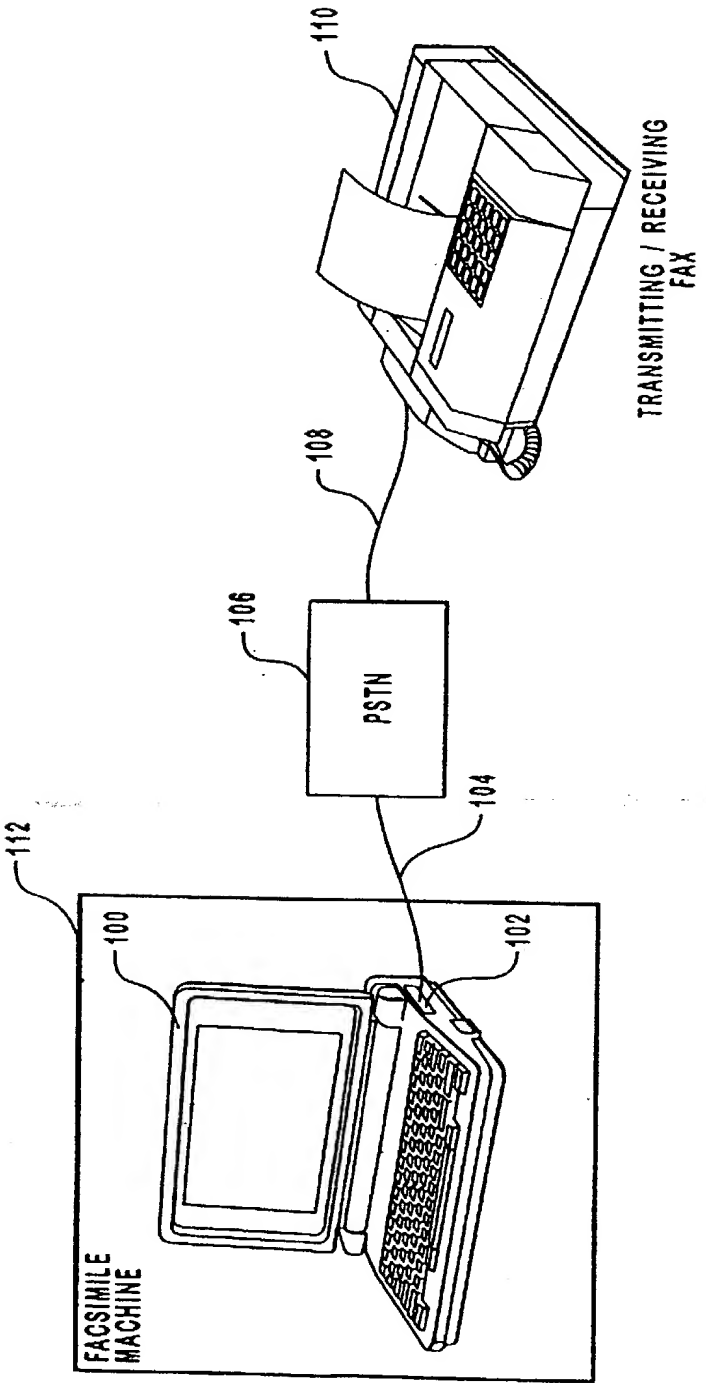


FIG. 1
(PRIOR ART)

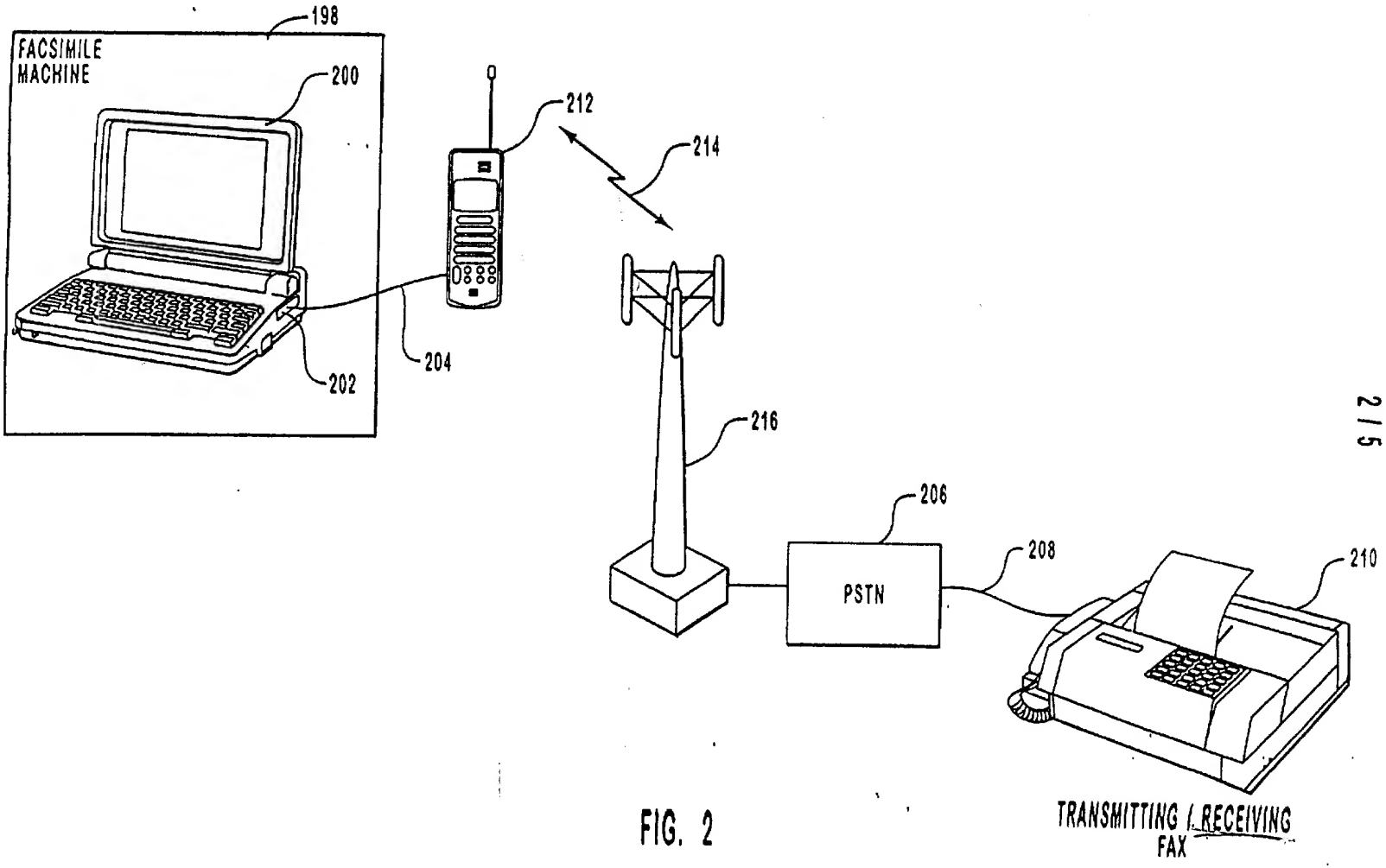

198
FACSIMILE MACHINE
200
202
204
212
214
216
206
PSTN
208
210
TRANSMITTING / RECEIVING FAX

FIG. 2

215

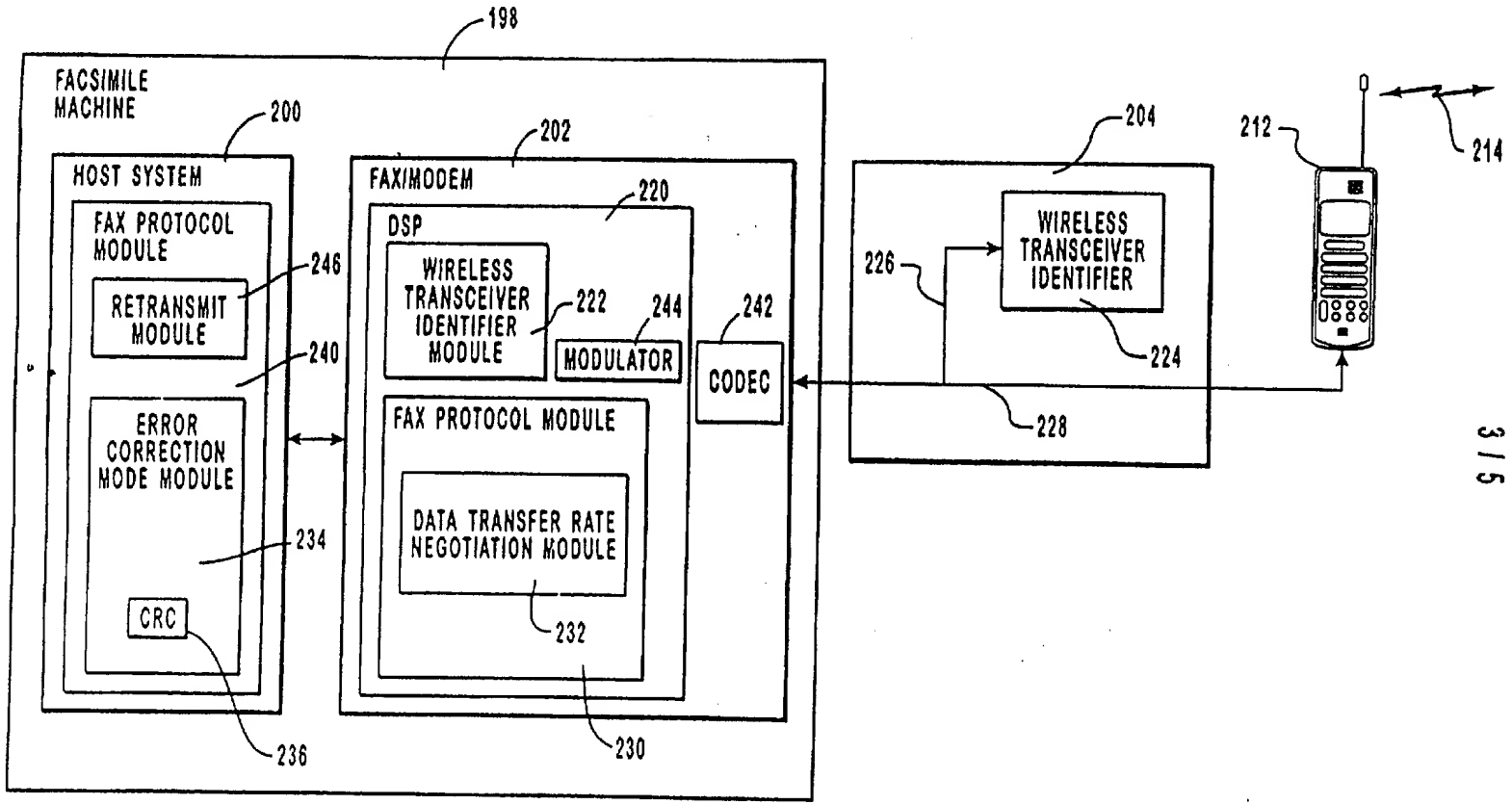

198
FACSIMILE MACHINE
200
HOST SYSTEM
FAX PROTOCOL MODULE
246
RETRANSMIT MODULE
240
ERROR CORRECTION MODE MODULE
234
CRC
236
202
FAX/MODEM
220
DSP
WIRELESS TRANSCEIVER IDENTIFIER MODULE
222
244
MODULATOR
242
CODEC
FAX PROTOCOL MODULE
DATA TRANSFER RATE NEGOTIATION MODULE
232
230
204
226
WIRELESS TRANSCEIVER IDENTIFIER
224
228
212
214

FIG. 3

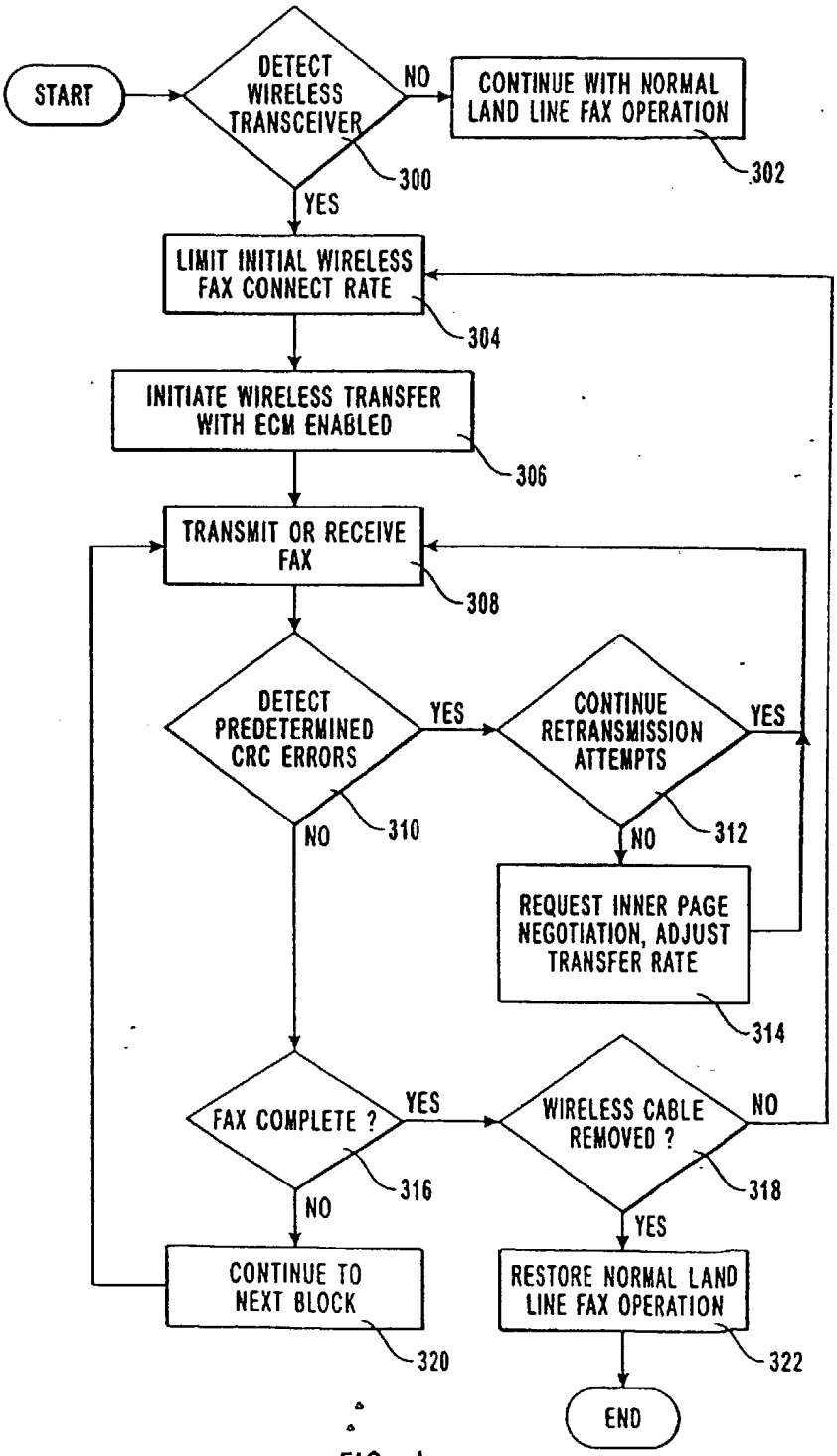

START
DETECT WIRELESS TRANSCEIVER
300
NO
CONTINUE WITH NORMAL LAND LINE FAX OPERATION
302
YES
LIMIT INITIAL WIRELESS FAX CONNECT RATE
304
INITIATE WIRELESS TRANSFER WITH ECM ENABLED
306
TRANSMIT OR RECEIVE FAX
308
DETECT PREDETERMINED CRC ERRORS
310
YES
CONTINUE RETRANSMISSION ATTEMPTS
312
YES
NO
NO
REQUEST INNER PAGE NEGOTIATION, ADJUST TRANSFER RATE
314
FAX COMPLETE ?
316
YES
WIRELESS CABLE REMOVED ?
318
NO
YES
NO
CONTINUE TO NEXT BLOCK
320
RESTORE NORMAL LAND LINE FAX OPERATION
322
END

FIG. 4

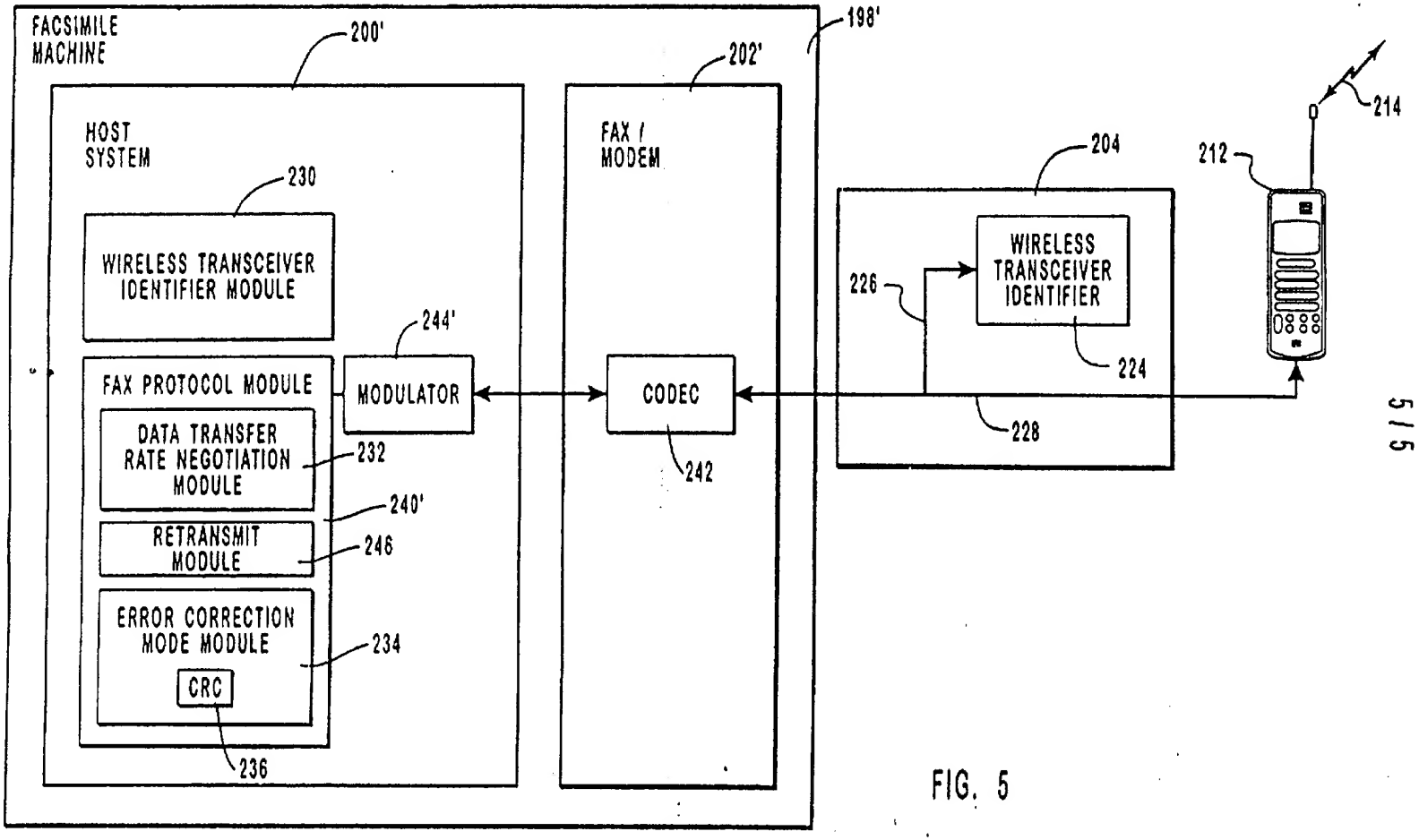

FACSIMILE MACHINE
200'
198'
202'
HOST SYSTEM
230
WIRELESS TRANSCEIVER IDENTIFIER MODULE
244'
FAX PROTOCOL MODULE
MODULATOR
DATA TRANSFER RATE NEGOTIATION MODULE
232
240'
RETRANSMIT MODULE
246
ERROR CORRECTION MODE MODULE
234
CRC
236
FAX / MODEM
CODEC
242
204
226
WIRELESS TRANSCEIVER IDENTIFIER
224
228
212
214

FIG. 5

BACKGROUND OF THE INVENTION

1. The Field of the Invention

This invention relates to facsimile transmission over a network structure. More particularly, this invention relates to facsimile transmission over a wireless communication channel wherein the wireless communication channel may exhibit fading and channel interference.

2. Description of Related Art

Thomas et al., United States Patent No. 5,649,001, which is hereby incorporated by reference in its entirety for the material disclosed therein, discloses a reconfigurable communication interface device to identify a valid communication adaptor cable.

3. Present State of the Art

Traditional facsimile transmissions have occurred over wired communication channels such as those characteristic of the public switch telephone network (PSTN). While such wired communication channels may be susceptible to interfering signals, interference on such hard wired communication channels is generally minimal. As such, facsimile transmission rates generally keep pace with technological advancements in modulation theory. For example, traditional facsimiles were transmitted at baud rates consistent with those of data modem transmissions. As modulation techniques for data modems advanced, so also did facsimile transmission techniques. Modernly, data transmission techniques may employ modulation rates in excess of 56.6 kilobits per second. Such high modulation rates require minimal noise injection onto the communication channel. As modulation data rates increase, the coding or frequency spacing between information bits becomes more narrow and

therefore more congested. Therefore, high modulation data rate techniques require robust communication channels for reliable transmission of high data rate data.

Technological advancements, in parallel with those of modulation advancements such as facsimile and data transmissions, have also occurred in the area of wireless communication. One such example were wireless technologies have become ubiquitous relates to cellular telephony. Cellular telephony, or more broadly wireless communication, enables a user to roam freely within a designated zone and establish a wireless communication channel with a remote party. Because of the roaming freedom available to a cellular telephone user, wireless communication channels exhibit varying levels of interfering noise, and hence reliability, during a particular communication session. In fact, during a particular transmission session a cellular user may widely roam, thereby subjecting the wireless communication channel to varying and ofttimes unpredictable levels of noise or interference.

In a communication session between a cellular telephone user and a remote party wherein the session parties are exchanging analog voice information, variations and interference are often tolerable due to the context nature of voice communication. Additionally, cellular users may also recognize the presence of interference due to their present location or orientation and institute corrective measures, such as repositioning the cellular transceiver to a more favorable location. When interference adversely affects a wireless voice communication session, a user may simply request that the other party repeat the previous statement.

As cellular technology advanced, cellular transceivers incorporated capability for facilitating transmission of data information across the established wireless communication channel. As a data transmitter and receiver, a facsimile machine became a candidate for interfacing with a cellular transceiver for sending and receiving facsimiles. Cellular transceiver users transceiving facsimiles over

cellular networks have become frustrated with the unreliability of transmissions primarily due to the interference impairments of wireless communication channels. Modern facsimile protocols recognize that impairments to communication channels result in injected errors within the facsimile transmission. At least one such facsimile protocol incorporates an error correction mode (ECM) wherein a block of facsimile data is partitioned and appended with a cyclically redundant code (CRC). A facsimile receiver, upon receipt of the partitioned block and appended CRC, evaluates the sequencing of data within the partitioned block and compares that sequencing against the corresponding appended CRC. When the CRC does not match the pattern as generated from the received data, an error in the transmitted data is detected. Techniques exist for accepting a predetermined number of errors in facsimile data without requesting the transmitting entity to retransmit the previous portion of facsimile data.

In wireless communication channels, however, typical interference frequently injects a substantial number of errors into the transmitted facsimile data portion, thus prohibiting a facsimile receiver from accepting that portion of the facsimile data. Such rejection causes the transmitter to retransmit the previous block of facsimile data. Frequently, a subsequent retransmission fares only as well as the previous transmission due to the characteristics of a wireless communication channel. Typically the result of such a scenario is that a transmitter and receiver continuously retransmit the same block of facsimile data until one party recognizes the futility of the present situation. As illustrated in Figure 1, a facsimile machine may take the form of an integrated device such as facsimile machine 110 or alternatively, may take the form of a host 100 such as a personal computer coupled to a fax modem 102 for performing the integrated facsimile function. As illustrated by Figure 1, a facsimile machine 110 and a facsimile machine 112 comprised of a host and a fax

modem, interoperate and communicate via wired communication channels 104 and 108 interconnected via a communication network 106 such as a public switched telephone network. Because of the wired connection between facsimile machines, minimal noise is injected into the communication channels thereby facilitating modulation techniques employing higher data rate techniques. While such high data rate modulation techniques may be adequate for wired communication channels, wireless communication channels, however, are far more susceptible to interference.

Thus, it appears that there exists no present technique for a facsimile machine to detect transmission of facsimile data over a wireless communication channel and modify the characteristics of the transmission of such facsimile data in such a manner to more reliably deliver facsimile data to a recipient facsimile machine. Furthermore, there does not currently exist techniques for determining the characteristic of the communication channel through which facsimile data will be transmitted and therefrom modify a retransmission criterion, recognizing that wireless communication channels may sustain an enhanced interference level for a sustained period of time. Therefore, a need exists for providing a method and system for recognizing a wireless communication channel as the channel through which facsimile data will be transmitted and accordingly modify accordingly the transmission characteristics of such a transmission of facsimile data.

SUMMARY AND OBJECTS OF THE INVENTION

It is an object of the present invention to provide a facsimile machine capable of detecting interconnection to a wireless transceiver for the establishment of a wireless communication channel through which facsimile data will be passed.

Another object of the present invention is to provide a facsimile machine capable of modifying the data transfer rate of facsimile data when a wireless communication channel is to be employed for transceiving facsimile data.

A still further object of the present invention is to provide a facsimile machine capable of detecting errors in facsimile data transferred over a wireless communication channel.

Yet another object of the present invention is to provide a facsimile machine capable of modifying the data transfer rate of facsimile data when retransmission attempts fail to eliminate errors in the facsimile data transferred over a wireless communication channel.

A still further object of the present invention is to provide a facsimile machine capable of modifying the data transfer rate of facsimile data over a wireless communication channel and reverting to normal data transfer rate selection when facsimile data reverts to transmission via a wired communication channel.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by the practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. To achieve the foregoing objects, and in accordance with the invention as embodied and broadly described herein, a method and system for modification of a data transmission rate for facsimile data over a wireless communication channel is provided.

Wireless communication channels provide new challenges for transmission of facsimile data due to the unpredictable levels of interference that are generally and transiently present. To accommodate such challenges in transmitting facsimile data, a facsimile machine is provided for compensating for such unpredictable characteristics of wireless transmissions. The facsimile machine of the present invention has an interface through which a wireless transceiver may be detected. The facsimile machine couples to a wireless transceiver through a connector which provides both a conduit for the transmission and reception of data information and furthermore provides a means for uniquely storing a wireless transceiver identifier which may be used to identify the capabilities and susceptibilities of the wireless transceiver. The wireless transceiver identifier stored within the connector coupling the facsimile machine with the wireless transceiver may be stored in a resident memory storage device such as a RAM or other medium in which a unique identifier may be presented. When the facsimile machine is unable to detect the presence of a wireless transceiver, the facsimile machine defaults to traditional transfer data rate negotiation techniques.

However, when the facsimile machine detects the presence of a wireless transceiver, a fax protocol module negotiates a data transfer rate in a traditional manner, but at a lower data transfer rate. For example, when the facsimile machine detects transmission of facsimile data targeted for a wireless communication channel, the facsimile machine reduces the data transfer rate to a more reliable level than the rate available over a wired communication channel. Such "throttling back" of data transfer rates may be accomplished by storing a series of suggested initial wireless transmission data rates in a table that may be indexed according to a wireless transceiver identifier. It should be noted that either a transmitting or a receiving facsimile machine coupled to a wireless transceiver may initiate the

reduction in data transfer rates by presenting the reduced transfer rate during the negotiation process prior to the exchange of facsimile data.

Additionally, during the establishment of the facsimile data exchange session, both the transmitting and receiving facsimile machines engage in exchange of information using an error correction mode which provides for the detection of errors injected into the facsimile data during the transmission process. Some traditional error correction modes include the use of a Class 1 or Class 2 facsimile transmission standard wherein a cyclically redundant code (CRC) is appended to the facsimile information for verification by the receiving party.

A transmitting facsimile then dispatches the facsimile data including the CRC to a receiving facsimile machine which in turn verifies the data to determine if the CRC appended to the facsimile information coincides with the newly generated CRC as calculated by the receiving facsimile machine. When no CRC errors are detected, the transmitting and receiving facsimile machines continue transceiving with a subsequent block of facsimile data. However, when the receiving facsimile machine detects an error in the transmitted facsimile information, a determination is made as to whether the number of errors within the facsimile data exceeds a predetermined error threshold. When the number of errors exceeds a predetermined threshold, a secondary determination is made as to whether a retransmission attempt of the same facsimile data should be undertaken. In one embodiment of the present invention, a threshold value designating the number of retransmissions to be undertaken before the facsimile transmission session is terminated is compared against the number of retransmissions already undertaken. When the number of retransmissions exceeds the retransmission threshold, the fax protocol module undertakes a renegotiation of the data transfer rate. Following the renegotiation of the data transfer rate, the transmitting facsimile, employing the newly renegotiated

data transfer rate, transmits the facsimile data to the receiving facsimile machine including an appended CRC thereby facilitating error detection by the receiving facsimile machine. Processing then continues as described above wherein the receiving facsimile machine evaluates the facsimile data to determine if any errors are present and if so, the extent of such errors. Retransmission decisions also are carried out as described above wherein when a retransmission threshold has not been exceeded, the transmitting facsimile machine retransmits the facsimile data at the present data transfer rate. The facsimile machine of the present invention further evaluates the presence of the connection of the wireless transceiver to determine when to revert back to normal wired communication channel data transfer rates when the wireless transceiver interface is terminated with the facsimile machine.

While the facsimile machine of the present invention may take the form of a traditional integrated facsimile machine, the present invention through the figures and detailed description describe a facsimile machine comprised of a host system such as personal computer or notebook computer and a fax modem interfaced to the host for providing the facsimile transceiving capability. In such an embodiment, the host system incorporates a portion of the fax protocol module in one embodiment while the fax modem incorporates a separate portion of the fax protocol module therein. In such an embodiment, the host system performs the error detection function and the retransmit evaluation function while the fax modem performs the data transfer rate negotiation and wireless transceiver identification. In a second embodiment, the host system performs additional functions by incorporating the modulation features as well as the fax protocol portions previously resident within the modem. Such a host signal processing system is commonly known in the industry as a Winmodem ore related architecture. Such architectures lend themselves to being more easily reconfigured by modifying the software within the

host system. In such architectures only traditional hardware functionality such as analog to digital and digital to analog conversion remains within the fax modem board.

While the previous description has been drawn to an architecture for carrying out the functionality of a facsimile machine, the methods for carrying out such functionality is also described for improving the successful transmission of facsimile data over a wireless communication channel. Additionally, the software modules for carrying out the above-described functionality are also described within the detailed description and the accompanying figures.

These and other objects and features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the manner in which the above-recited and other advantages and objects of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

Figure 1 is a simplified diagram of facsimile machines interconnected through an interconnection network employing wired communication channels, in accordance with the prior art;

Figure 2 is a simplified diagram of facsimile machines interconnected through a wireless infrastructure via a wireless communication channel, in accordance with an embodiment of the present invention;

Figure 3 is a simplified block diagram of a facsimile machine interfaced with the wireless transceiver for communication over a wireless communication channel, in accordance with the preferred embodiment of the present invention; and

Figure 4 is a flowchart for modifying fax data transfer rates over wireless communication channels; and

Figure 5 is a simplified block diagram of a facsimile machine interfaced with the wireless transceiver for communication over a wireless communication channel wherein the host system incorporates a portion of traditional modem functionality therein, in accordance with an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention embodies within its scope both methods and systems for modifying transmission and reception data rates for facsimile data transceived over wireless communication channels. The present invention further embodies methods and systems for detecting the presence of a wireless communication channel and modifying the data transmission rate of either a transmitting facsimile machine or a receiving facsimile machine. Furthermore, the present invention embodies a facsimile machine comprised of a host system such as a computer interfacing with a fax modem capable of transmitting and receiving facsimile data.

As described in Figure 1, facsimile data has traditionally been transferred over wired communication channels. The present invention contemplates the mobility of facsimile data generators and recipients and provides both a system and method for transceiving facsimile data over a wireless communication channel. The present invention contemplates the nuances associated with wireless communication channels and provides a system and method for enhancing the reliability of transceived facsimile data.

Figure 2 is a simplified block diagram of a first facsimile machine interfacing with a second facsimile machine via a wireless communication channel, in accordance with a preferred embodiment of the present invention. Traditional facsimile machines have assumed an integrated footprint largely akin to a computer printer coupled with a telephone handset. While such traditional facsimile machines are considered to be within the scope of the present invention, Figure 2 illustrates an alternative implementation of a facsimile machine. A facsimile machine 198 is illustrated as being comprised of a host 200 and a fax modem 202. Host 200 may take the form of a computer such as a personal computer and for more mobile applications, host 200 may take the form of a notebook or portable computer. Fax

modem 202 provides the modulation and demodulation for facsimile data which traditionally takes the form of digital data. Fax modem 202, as illustrated in Figure 2, takes the form of an I/O circuit board such as an ISA, PCMCIA or other like interface assemblies supported by host 200.

Facsimile machine 198 interfaces with a wireless transceiver 212 via a cable 204. Wireless transceiver 212 may take the form of a cellular telephone or other wireless transceiver known by those of skill in the art. Cable 204 provides a conduit through which facsimile data may be dispatched between facsimile machine 198 and transceiver 212. While wireless transceiver 212 and facsimile machine 198 are illustrated as discreet components, an integrated version of facsimile machine 198 and wireless transceiver 212 is contemplated by the inventors as being within the scope of the present invention. Additionally, as disclosed above, facsimile machine 198 may also assume an integrated form factor distinct from a computer and fax modem.

Wireless transceiver 212 transceives facsimile data over a wireless communication channel 214 established with wireless infrastructure 216. Wireless infrastructure 216 may take the form of cellular wireless infrastructure, PCS wireless infrastructure or other wireless infrastructure employing propagation of electromagnetic signals as its preferred method of communication.

Wireless infrastructure 216 interfaces with a wired communication network 206 to provide the appropriate routing via a wired communication channel 208 to a remote facsimile machine 210. Alternatively, wireless infrastructure 216 may establish a second wireless communication channel (not shown) thereby bypassing any wired communication channel and relying solely on wireless communication channels as a means of connecting facsimile machine 198 with facsimile machine 210. Communication network 206 may take the form of the

public switch telephone network (PSTN) or other established, or yet to be established, computer networks including the integrated services digital network (ISDN).

Facsimile machine 210, while illustrated as a traditionally integrated facsimile machine, may also take other forms such as that illustrated by facsimile machine 198. That is to say, facsimile machine 210 may be comprised of a host and a separate or integrated fax modem for providing traditional modulation functionality. Additionally, facsimile machines 198 and 210 need not provide printing or display capabilities for facsimile data as illustrated by the display of facsimile machine 198 and the printing capabilities as illustrated by facsimile machine 210. The present invention contemplates only the need for facsimile machines 198 and 210 to exchange facsimile data therebetween.

Figure 3 is a more detailed block diagram of a facsimile machine interfacing with a wireless transceiver for exchange of facsimile data over a wireless communication channel, in accordance with a preferred embodiment of the present invention. Facsimile machine 198, as described above, may be broadly comprised of a host 200 and a fax modem 202. Host 200 may take the form of a personal computer or other microprocessor or microcontroller configuration capable of executing programmed instructions. Host 200 is illustrated as being inclusive of a program or software application comprised of a fax protocol module 240. Fax protocol 240 executes the selected or established facsimile protocol necessary for compatible exchange of imagery or other descriptive data.

In the present invention, the facsimile protocols contemplated within the scope of the present invention include Class 1, Class 2 and other facsimile protocols incorporating error detection capabilities. In Figure 3, facsimile protocol module 240 illustrates the error detection capability module associated with a compatible

facsimile protocol. Figure 3 illustrates the use of facsimile protocol Class 1 incorporating an error correction mode module 234 for use in detecting transmission errors incurred across a communication channel. Error correction mode module 234 incorporates a cyclically redundant code (CRC) 236 as an error correction appendage to the information portion of the facsimile data containing the transmitted facsimile information. [Host 200, when operating as a portion of a transmitting facsimile machine, generates and appends the CRC to the facsimile information to form the facsimile data.] Conversely, when host 200 operates as a portion of a receiving facsimile machine, error correction mode module 234 generates a CRC from the received facsimile information and compares the CRC generated at the receive facsimile machine from that originating at the transmit facsimile machine. When the CRCs do not match, error correction mode module 234 detects the presence of an error as injected by the communication channel.

A fax modem operably couples to host 200 via a compatible interface such as those known by those of skill in the art. Fax modem 202 comprises a processing means for executing programmed instructions such as a digital signal processor 220 or other microprocessor or embedded controller. DSP 220 comprises software modules including a wireless transceiver identifier module 222, fax protocol module 230 and modulator 244. Wireless transceiver identifier module 222 interrogates cable 204 to deduce wireless transceiver identifier 224 as further detailed below and fax protocol module 230 performs data transfer rate negotiation via a data transfer rate negotiation module 232. Data transfer rate negotiation module 232 further facilitates the renegotiation of inner page changes to the data transfer rate. In one embodiment of a fax protocol, data rate negotiation and renegotiation occurs by exchange of a notification such as a tone exchange followed by data rate renegotiation at a more robust default rate that is generally a rate substantially below

the original and target data transfer rates. Modulator 244 performs modulation and demodulation of digital data for propagation over communication channels. Fax modem 202 further comprises a CODEC 242 for performing analog to digital and digital to analog conversion of the modulated data. Implementation and integration of CODECs are known by those of skill in the art and therefore are not further discussed herein.

Facsimile machine 198 interfaces with wireless transceiver 212 via a cable 204. Cable 204 incorporates a data bus 228 for facilitating a data path between facsimile machine 198 and wireless transceiver 212. Data bus 228 may take the form of a serial bus including a clock and data signal or a parallel bus or other bus architectures known by those of skill in the art. Several standardized data bus architectures exist for interfacing digital data in modulated format between a modem and cellular or other wireless transceiver.

As discussed above, the present invention provides a method and system whereby a facsimile machine may detect the presence of a wireless communication channel through which facsimile data must traverse. Numerous methods of detecting a wireless communication channel are considered to be within the scope of the present invention. In a preferred embodiment of the present invention, cable 204 may be uniquely configured to a particular model or group of models of a wireless transceiver 212. For example, wireless transceiver 212 fabricated by a first manufacture incorporates a first data interface through which facsimile data passes, while a second manufacture may fabricate a wireless transceiver incorporating a second bus standard through which facsimile data passes.

To accommodate and compatibly communicate with a diverse variety of wireless transceivers, fax modem 202 may benefit from having insight as to the capabilities and type of wireless transceiver interfaced therewith. In the preferred

embodiment, cable 204 further incorporates a wireless transceiver identifier 224 uniquely identifying a set or subset of wireless transceivers having particular capabilities. Fax modem 202 interrogates cable 204 via an identification bus 226 to derive wireless transceiver identifier 224 uniquely identifying a type of wireless transceiver 212. As a result of the presence of wireless transceiver identifier 224, fax modem 202 identifies data bus 228 as connecting with a wireless transceiver. One such cable interface as described above is illustrated in U.S. Patent No. 5,649,001 to Thomas et al., as incorporated by reference above.

By identifying the interconnection of fax modem 202 with wireless transceiver 212, fax protocol 230 and data rate negotiation module 232 may consider the practicalities of wireless communication channels in making a data transfer rate selection. The limitations of wireless communication channels are widely known and dealt with for voice communication transmissions. That is to say, voice users of wireless communication channels may better tolerate interference and fading associated with the physical limitations of wireless communication channels. For example, small losses of voice information may be tolerated in voice communications as the human mind can accommodate minor lapses in voice information by reconstructing voice information from context information surrounding the lost information. Additionally, voice users of wireless communication channels may take proactive measures that enhance the characteristics of wireless communication channels such as modifying the orientation of a wireless transceiver or temporarily postponing the dispatch of voice information until an interfering condition passes. However, employing subjective and humanistic decision in highly automated data transmission systems such as those exchanging facsimile data is infeasible. Therefore, data transfer rate negotiation module 232 incorporates the practicalities of a wireless communication channel for

data transfer in making a decision to reduce the data transfer rate negotiated for facsimile data transfer.

Figure 4 is a flowchart for modifying a data transfer rate of facsimile data over wireless communication channel, in accordance with the preferred embodiment of the present invention. As described above, wireless communication channels present differing challenges for transmission of facsimile data as opposed to transmission of voice information. To accommodate data transmission of facsimile data over a wireless communication channel, improving the probability of accurate reception of facsimile data must be paramount. Therefore, facsimile machine 198 (Figure 3) employs the method as depicted in Figure 4 to enhance the probability of successful reception of accurate facsimile data.

A detect wireless transceiver query step 300 performs an evaluation of the type of communication channel to be employed for the transmission of facsimile data. When query step 300 determines a wired communication channel will be employed, a task 302 performs traditional fax data transmission and reception procedures. However, when detect wireless transceiver query step 300 determines, for example through a query of cable 204 (Figure 3), that a wireless transceiver is interconnected therewith, facsimile machine 198 (Figure 3) makes a determination to limit the initial data transfer rate in step 304. Data transfer rate limitations may be imposed by the capabilities of wireless transceiver 212 (Figure 3) as determined by wireless transceiver identifier 224 (Figure 3) or data transfer rates may be limited by the modulation techniques employed by facsimile machine 198 (Figure 3) which are not conducive for wireless electromagnetic propagation.

Once a data transfer rate of facsimile data has been determined, an initiate wireless transfer of facsimile data employing an error correction mode step 306 establishes a wireless session for transmission of facsimile data. When facsimile

machine 198 (Figure 3) is position as a transmitting facsimile machine, the transmitting facsimile machine requests the data rate transmission capability from the receiving facsimile machine. The transmitting facsimile machine upon receipt of the receiving facsimile machine's capability, makes a determination based upon the receiving facsimile machine's capability in conjunction with its own transmission capability to determine the data transmission rate to be employed during the facsimile data transmission session. Conversely, when facsimile machine 198 (Figure 3) assumes the position of being the receiving facsimile machine, the receiving facsimile machine divulges the transmission capabilities to the transmitting facsimile machine for use in determining a data transmission rate for the facsimile data transmission session. In either role, the facsimile machine interconnected with a wireless transceiver selects a data transmission rate more compatible with wireless propagation during the establishment and negotiation of the facsimile data transfer session. Such a selection of a reduced data transfer rate may result from consultation of a transfer rate table resident within host 200 or fax modem 202 as indexed by wireless transceiver identifier 224.

A transmitter receive fax step 308 commences with the dispatch or the reception of facsimile data as processed and packaged by the transmitting facsimile machine. A query step 310 evaluates the CRC associated with the facsimile information contained within the facsimile data to determine the presence of errors injected through the wireless communication channel. Query task 310 compares the quantity of errors detected with a predetermined threshold quantity in making a determination of whether to accept or reject the presented facsimile data. When the threshold of CRC errors is exceeded, a query task 312 performs a determination of either (i) to continue by employing a retransmission process thereby anticipating an improved wireless communication channel or (ii) when retransmission of the

facsimile data is considered futile, such as when retransmission attempts for a threshold number of times have also failed, to request inner page negotiation step 314 to adjust the data transmission rate. The inner page negotiation procedure in the preferred embodiment conforms to the Class 1 facsimile specification wherein a tone is transferred to the transmitting modem requesting a renegotiation of the data transfer rate using a reduced frequency. Processing then returns back to a further attempt to transfer or receive facsimile data at the revised data rate.

When query task 310 does not detect a sufficient number of CRC errors, a facsimile complete query step 316 evaluates the present completion status of the quantum of facsimile data. When a portion of the facsimile information remains to be transmitted, a task 320 continues the transmission of the subsequent block of facsimile data.

When query task 316 determines the facsimile data has been completely transferred, a query task 318 monitors the connect-status of cable 204 in a step 318 to detect a disconnection of facsimile machine 198 (Figure 3) with wireless transceiver 212 (Figure 3). When cable 204 is disconnected with facsimile machine 198 (Figure 3), a task 322 restores normal land line fax operation. When query task 318 determines that cable 204 remains connected to fax modem 202, processing returns back to step 304 wherein the initial negotiated data transfer rate will be modified since facsimile data will be traversing a wireless communication channel.

Figure 5 is a simplified block diagram of an alternate embodiment of a facsimile machine interfacing with a wireless transceiver for the transmission of facsimile data over a wireless communication channel, in accordance with the present invention. In an alternate embodiment, a facsimile machine 198' is comprised of a host system 200' and a fax modem 202'. In this present embodiment,

facsimile machine 198' incorporates the digital signal processing functionality into the host rather than the fax modem of the prior embodiment. Host system 200' may take the form of a personal computer wherein the majority of modem functionality is incorporated into the host system with only minimal functionality remaining within fax modem 202'. Such minimum functionality includes CODEC function 242 which converts between analog and digital formats.

Host system 200' is comprised of a wireless transceiver identifier module 230 previously resident within fax modem 202 (Figure 3) for reading wireless transceiver identifier 224 located within cable 204. Host system 200' further comprises fax protocol module 240' which carries out the fax protocol, such as Class 1, by performing data transfer rate negotiation module 232 and error correction mode module 234 as detailed above in Figures 3 and 4.

The present embodiment incorporates advanced digital signal processing executed within the host system, also known as native signal processing or host signal processing. Furthermore, native signal processing techniques involving modem functionality have also come to be known by other descriptive names such as Winmodem and other proprietary designations. . st system 200' further incorporates modulation functionality in a modulator 244' providing modulation and demodulation of facsimile data.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respect only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed and desired to be secured by United States Letters Patent is:

1. In a facsimile machine interfaced to a wireless transceiver, a method for improving successful transmission of facsimile data over a wireless communication channel, said method comprising the steps of:

a) detecting an interface of said facsimile machine with said wireless transceiver for transceiving said facsimile data over said wireless communication channel;

b) establishing said wireless communication channel with an initial data transfer rate corresponding with the capability of said wireless transceiver as a data transfer rate;

c) transceiving said facsimile data over said wireless communication channel; and

d) altering said data transfer rate when said facsimile data includes data errors resulting from transmission over said wireless communication channel.

2. The method as recited in claim 1, wherein said detecting said interface of said facsimile machine with said wireless transceiver step comprises the step of said facsimile machine reading an identifier designating a specific type of said wireless transceiver.

3. The method as recited in claim 2, wherein said reading said identifier step comprises the step of reading said identifier associated with a connector interfacing said facsimile machine with said wireless transceiver, said connector being unique to a type of said wireless transceiver.

4. The method as recited in claim 1, wherein said establishing said wireless communication channel with an initial data transfer rate step further comprises selecting an initial data transfer rate corresponding to a rate less than the maximum data transfer rate capable by said wireless transceiver.

5. The method as recited in claim 1, wherein said establishing said wireless communication channel with an initial data transfer rate step further comprises the step of employing a facsimile transmission standard that incorporates error detection, retransmission and data transfer rate renegotiation capabilities.

6. The method as recited in claim 5, wherein said facsimile transmission standard takes the form of the class 1 facsimile standard further employing the error correction mode (ECM) capability therein.

7. The method as recited in claim 1, wherein said altering said data transfer rate when said facsimile data includes data errors step comprises the steps of:

a) when said facsimile machine receives said facsimile data, requesting a lower data transfer rate of a transmitting facsimile machine;

b) when said facsimile machine transmits said facsimile data, reducing said data transfer rate when requested by a receiving facsimile machine.

8. The method as recited in claim 7, wherein when said facsimile machine receives facsimile data, requesting a reduction of said data transfer rate when a threshold number of retransmissions at said transfer data rate have failed.

9. The method as recited in claim 1, further comprising the step of when said facsimile machine ceases to detect said wireless transceiver, said facsimile machine establishing a communication channel through negotiation of said initial data transfer rate corresponding with the capability of said facsimile machine.

10. A facsimile machine capable of modifying a data transfer rate of facsimile data transceived over a wireless communication channel, comprising:

a) a fax modem including a wireless transceiver identifier module to detect an interface of said facsimile machine with a wireless transceiver and to negotiate and renegotiate said data transfer rate for said facsimile data consistent with the capability of said wireless transceiver; and

b) a host operatively coupled with said fax modem to execute a fax protocol employing error detection functionality.

11. The facsimile machine as recited in claim 10, wherein said fax modem further comprises a fax protocol module for performing said negotiation and renegotiation of said data transfer rate for said facsimile data.

12. The facsimile machine as recited in claim 11, wherein said fax protocol module comprises a data transfer rate negotiation module compliant with the class 1 facsimile protocol.

13. The facsimile machine as recited in claim 10, wherein said host further comprises a fax protocol module incorporating error correction mode (ECM).

14. The facsimile machine as recited in claim 13, wherein said fax protocol module further comprises a retransmission module for attempting retransmission of protocol data for a threshold number of times.

15. A fax modem capable of modifying a data transmission rate of facsimile data transceived over a wireless communication channel, comprising:

a) a wireless transceiver identifier module to detect connection with a wireless transceiver; and

b) a fax protocol module to negotiate and renegotiate said data transfer rate for said facsimile data consistent with the capability of said wireless transceiver.

16. The fax modem as recited in claim 15, wherein said fax protocol module comprises a data transfer rate negotiation module compliant with the Class 1 facsimile protocol.

17. A computer-readable medium for a facsimile machine interfaced to a wireless transceiver to improve transmission of facsimile data over a wireless communication channel, said computer-readable medium having computer-executable instructions for performing steps comprising:

a) detecting an interface of said facsimile machine with said wireless transceiver for transceiving said facsimile data over said wireless communication channel;

b) establishing said wireless communication channel with an initial data transfer rate corresponding with the capability of said wireless transceiver as a data transfer rate;

c) transceiving said facsimile data over said wireless communication channel; and

d) altering said data transfer rate when said facsimile data includes data errors resulting from transmission over said wireless communication channel.

18. The computer-readable medium of claim 17, having further computer executable instructions wherein said detecting said interface of said facsimile machine with said wireless transceiver step comprises computer-executable instructions for performing the step of said facsimile machine reading an identifier designating a specific type of said wireless transceiver.

19. The computer-readable medium of claim 18, having further computer executable instructions wherein said reading said identifier step comprises computer executable instructions for performing the step of reading said identifier associated with a connector interfacing said facsimile machine with said wireless transceiver, said connector being unique to said wireless transceiver.

20. The computer-readable medium of claim 17, having further computer executable instructions wherein said establishing said wireless communication channel with an initial data transfer rate step further comprises computer executable instructions for performing the step of selecting an initial data transfer rate corresponding to a rate less than the maximum data transfer rate capable by said wireless transceiver.

21. The computer-readable medium of claim 17, having further computer executable instructions wherein said establishing said wireless communication channel with an initial data transfer rate step further comprises computer executable instructions for performing the step of employing a facsimile transmission standard that incorporates error detection, retransmission and data transfer rate renegotiation capabilities.

22. The computer-readable medium of claim 17, having further computer executable instructions wherein said altering said data transfer rate when said facsimile data includes data errors step comprises computer executable instructions for performing the steps of:

a) when said facsimile machine receives said facsimile data, requesting a lower data transfer rate of a transmitting facsimile machine;

b) when said facsimile machine transmits said facsimile data, reducing said data transfer rate when requested by a receiving facsimile machine.

23. The computer-readable medium of claim 22, having further computer executable instructions wherein when said facsimile machine receives facsimile data, requesting a reduction of said data transfer rate when a threshold number of retransmissions at said data transfer rate have failed.

24. The computer-readable medium of claim 17, having further computer executable instructions for performing the step of whe said facsimile machine ceases to detect said wireless transceiver, said facsimile machine establishing a communication channel through negotiation of said initial data transfer rate corresponding with the capability of said facsimile machine.

25. A method for improving successful transmission of facsimile data over a wireless communication channel substantially as hereinbefore described.

26. A facsimile machine capable of modifying a data transfer rate of facsimile data transceived over a wireless communication channel substantially as hereinbefore described.

27. A fax modem capable of modifying a data transmission rate of facsimile data transceived over a wireless communication channel substantially as hereinbefore described.

28. A computer readable medium for a facsimile machine interfaced to a wireless transceiver to improve transmission of facsimile data over a wireless communication channel substantially as hereinbefore described.

The Patent Office

Application No:	GB 9810300.5	**Examiner:**	Gareth Griffiths
Claims searched:	All	**Date of search:**	2 November 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4L (LDGP, LDGX, LDLX, LDSU, LDSY, LECX)

Int Cl (Ed.6): H04B 7/24, 7/26, H04L 1/12, H04Q 7/22, 7/32, 7/38

Other: Online Database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2322047 A	(SIEMENS) p.10 line 17 - p.11 line 5	1, 10, 15, 17 at least
X	EP0353759 A2	(NORAND) whole document	1, 10, 15, 17 at least
X	US5526399	(KAMEDA) col.2 line 36 - col.4 line 16	1, 10, 15, 17 at least
X	US4939731	(REED) whole document	1, 10, 15, 17 at least
X	US4710925	(NEGI) whole document	10, 15 at least
X	US4630126	(KAKU) whole document	10, 15 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Sept. 14, 1943. W. SIEGENTHALER 2,329,302

COP WINDING MACHINE

Filed June 3, 1941 4 Sheets-Sheet 1

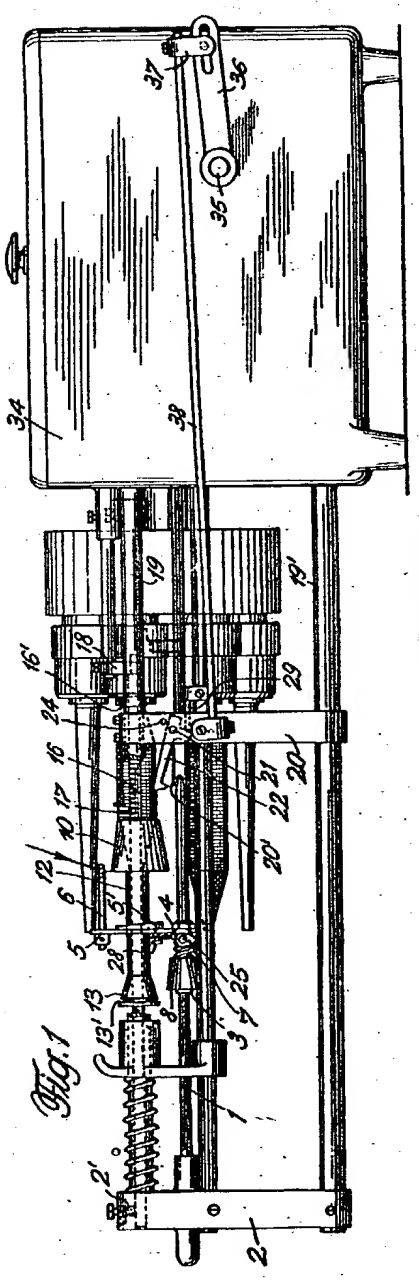


Fig. 1

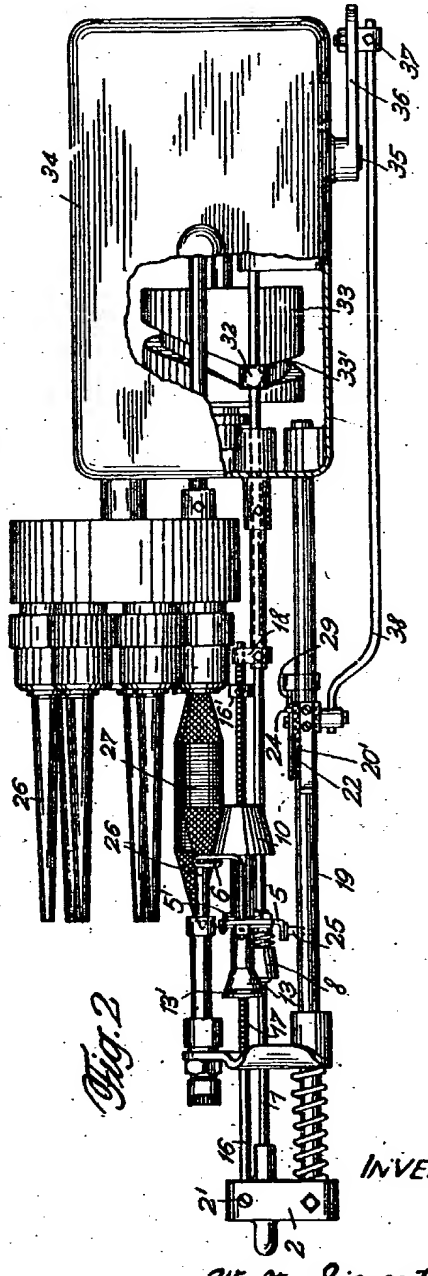


Fig. 2

INVENTOR:

Walter Siegenthaler

by Sommer & Young

Attorneys

Sept. 14, 1943. W. SIEGENTHALER 2,329,302

COP WINDING MACHINE

Filed June 3, 1941 4 Sheets-Sheet 2

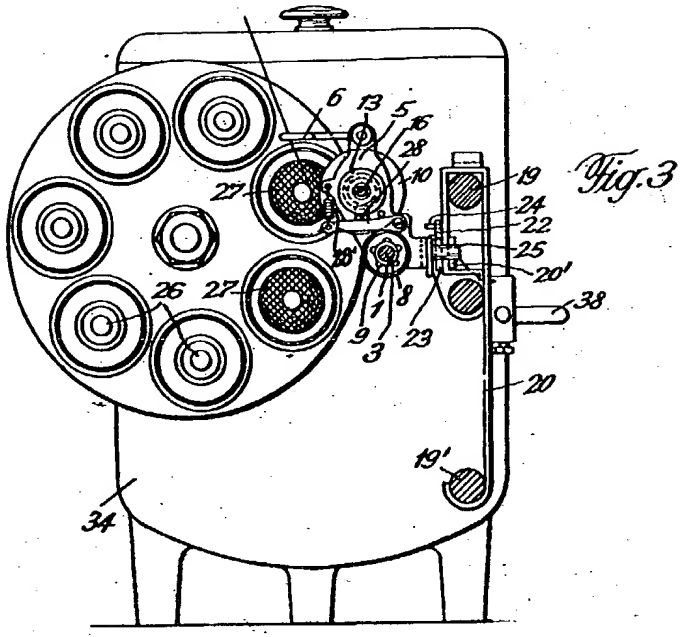


Fig. 3

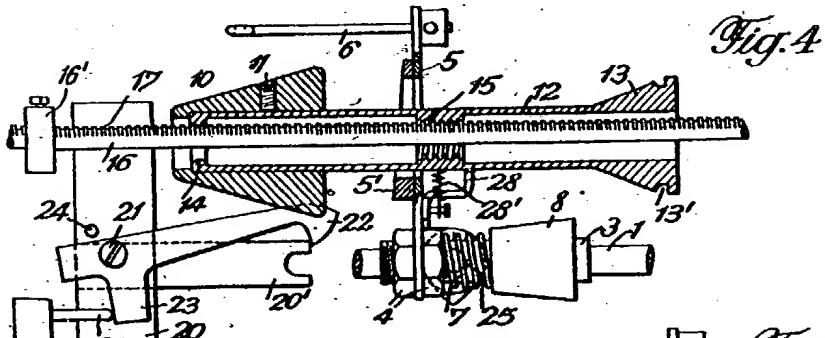


Fig. 4

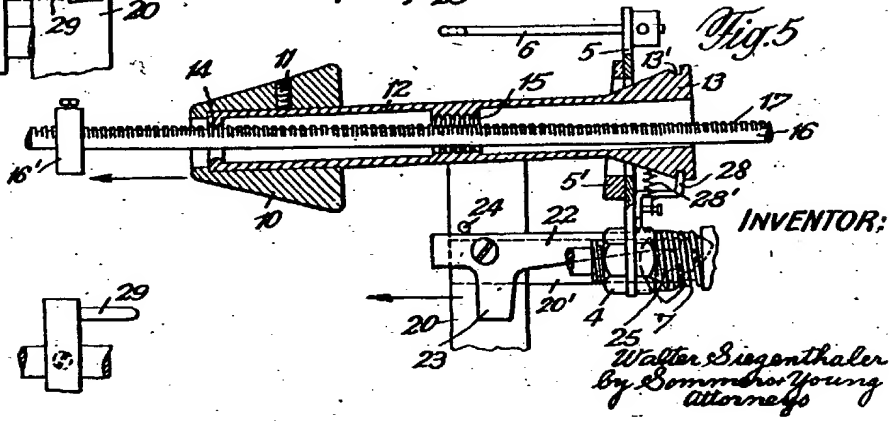


Fig. 5

INVENTOR:
Walter Siegenthaler
by Bommhardt Young
Attorneys

Sept. 14, 1943. W. SIEGENTHALER 2,329,302

COP WINDING MACHINE

Filed June 3, 1941 4 Sheets-Sheet 3

Fig. 6

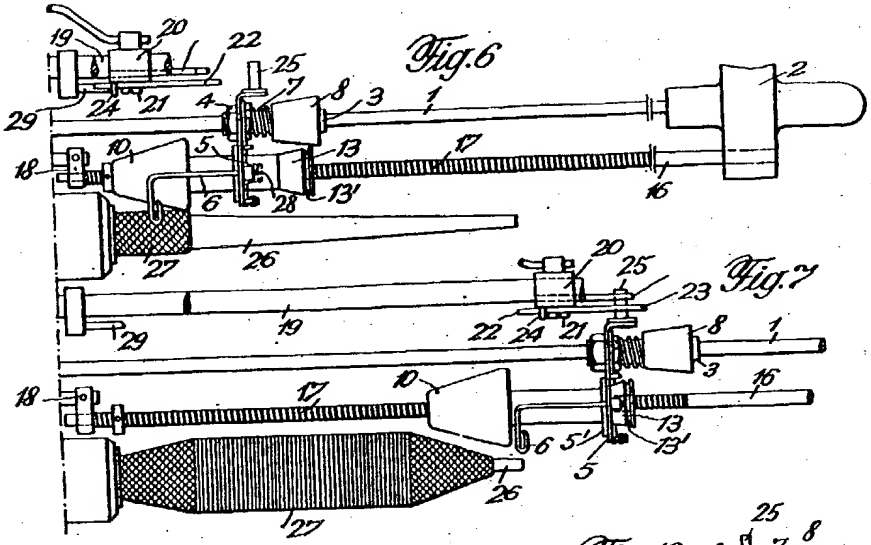


Fig. 7

Fig. 8

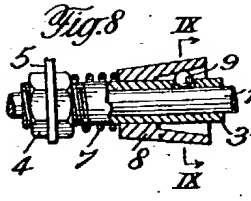


Fig. 9

Fig. 10

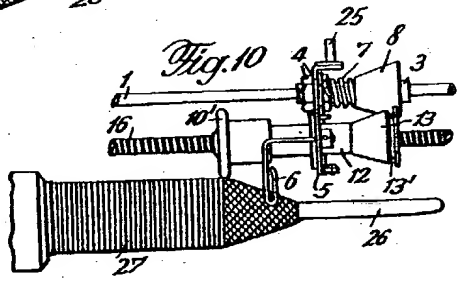
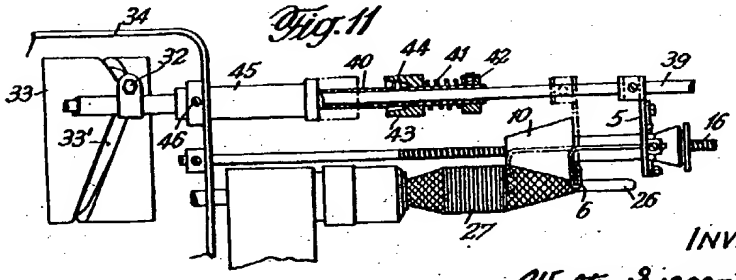


Fig. 11



INVENTOR:
Walter Siegenthaler
by Sommer & Young
Attorneys

Sept. 14, 1943. W. SIEGENTHALER 2,329,302

COP WINDING MACHINE

Filed June 3, 1941 4 Sheets-Sheet 4

Fig. 12

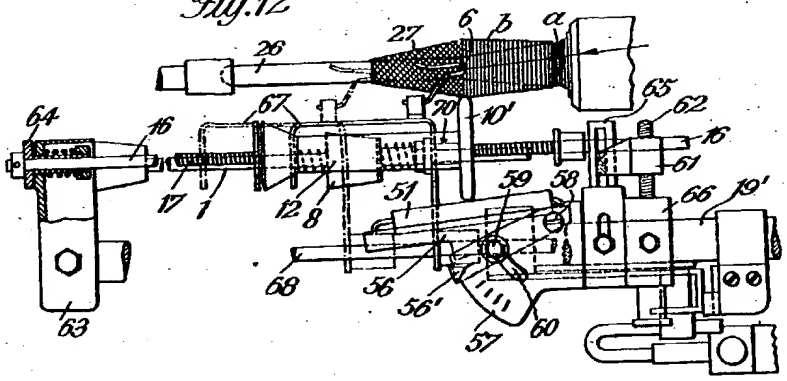


Fig. 16

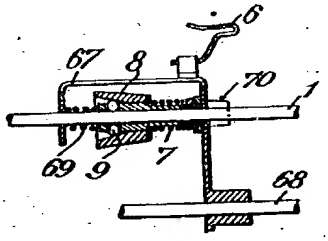


Fig. 13

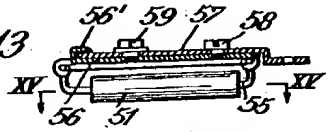


Fig. 14

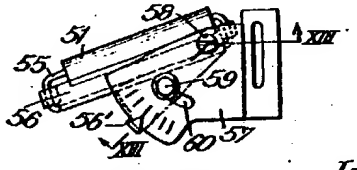
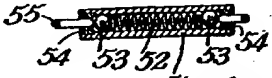


Fig. 15



Inventor:
Walter Siegenthaler
by Sommers & Young
Attorneys

Patented Sept. 14, 1943 2,329,302

UNITED STATES PATENT OFFICE

2,329,302

COP WINDING MACHINE

Walter Siegenthaler, Erlenbach, Zurich, Switzerland, assignor to Maschinenfabrik, Schärer, Erlenbach, Zurich, Switzerland

Application June 3, 1941, Serial No. 396,464
In Switzerland June 18, 1940

15 Claims. (Cl. 242—30)

This invention relates to cop winding machines.

The cop winding machine according to the invention comprises in combination a thread guide and a winding feeler means which means is intermittently advanced by means of a screw bore on the screw thread of a guide spindle in dependence upon the working operation, thereby advancing also the thread guide, the winding feeler means engaging into the screw thread of the spindle by the action of its own weight, and means being provided for disengaging the winding feeler means from the screw thread of the spindle, when the winding is completed, slidingly returning the winding feeler means into initial position, and then effecting interengagement between said winding feeler means and said screw thread again.

By this means reliability of feeding is ensured with the aid of simple means. The winding feeler means can smoothly rotate, due to the absence of a spring being forced into engagement with the screw thread of the spindle which would resist more or less the rotating movement of the winding feeler means and would thus eventually invite damage to the cop winding.

An embodiment of the invention, and modifications of the feed device are illustrated in the accompanying drawings by way of example only, in which

Fig. 1 is an elevation of the machine showing the thread guide removed from a conical winding feeler member;

Fig. 2 is a top plan view of Fig. 1;

Fig. 3 is a front view of Fig. 1 partly in section;

Fig. 4 shows a longitudinal section of the feed device on a larger scale;

Fig. 5 depicts a view similar to Fig. 3 after the screw thread of the winding feeler means has been disengaged from the screw thread of the guide spindle;

Fig. 6 is a top plan view of a modification of the feed device;

Fig. 7 is a view similar to Fig. 6 but with feed members in different positions;

Fig. 8 shows an elevation of a clamping mechanism partly in an axial section;

Fig. 9 is a cross section on the line IX—IX in Fig. 8;

Fig. 10 shows an elevation of another modification of the feed device;

Fig. 11 shows a modification of the feed device shown in Fig. 10;

Fig. 12 illustrates in a top plan view the combination with the winding feeler means of a cooperative linear guide;

Fig. 13 is a sectional view taken along the line XIII—XIII in Fig. 14;

Fig. 14 is a top plan view of Fig. 13;

Fig. 15 shows a partial section taken along the line XV—XV in Fig. 13; and

Fig. 16 is a sectional view of the carrier for the thread guide.

In the embodiment shown in Figs. 1–5, the numeral 1 designates a thread guide carrier rod which is longitudinally reciprocated during the cop building operation, which movement is derived from a driving member 32 through the intermediary of a groove 33' of a rotating traversing cam 33 arranged in a gear box 34. The end of the thread guide carrier rod 1 remote from the gear box 34 is mounted in a mounting member 2 which is firmly connected to the gear box by a bar 15'. On the thread guide carrier rod 1 a sleeve 3 is mounted (see also Fig. 3) to which is firmly secured a carrier arm 5 of a thread guide 6 by means of screw nuts 4. On one of the nuts 4 abuts a coil spring 7 which cooperates with a clamping sleeve 8 which is pushed on the sleeve 3 and cooperates by means of a conical inner surface with locking balls 9 which are distributed round the circumference of said surface and are inserted in sockets in the sleeve 3. The locking balls 9 can be so forced against the thread guide carrier rod 1 by the clamping sleeve 8 that this rod is connected to the sleeve 3 and thus to the thread guide 6 for common movement.

With the carrier arm 5 of the thread guide 6 cooperates a conical body 10 representing the thread feeler member which member is axially adjustable relative to a carrier sleeve 12 by means of a screw 11 (Fig. 4). The sleeve 12 is provided at one end with a terminal cone 13 having an annular groove 13' and at the other end with a rounded off rim 14 located within the sleeve bore, whilst the central part of the bore is provided with a narrowed threaded portion 15. The winding feeler member 10 is mounted on the guide spindle 16 by means of the sleeve 12 associated therewith, the spindle carrying a screw thread 17 which extends over a circumferential portion of the guide spindle 16 amounting to slightly less than the upper half of the circumference of the spindle 16. As shown in Fig. 4 the screw thread 15 of the sleeve 12 is in engagement with the screw thread 17 of the guide spindle 16. The feeler carrier sleeve 12 has a clear bore of such a diameter that the sleeve 12 can be disengaged from the screw thread 17 of the guide spindle by moving the sleeve crosswise. As shown in Figs. 1 and 2 the guide spindle 16 is held at one

end in the mounting member 2 by means of a screw 2', whereas the other end of the spindle is carried by a mounting arm 18 arranged on the gear box 34.

A slide 20 is slidably guided by two rods 19, 19' and carries by means of a screw 21 a pivotal catch 22 having a downwardly directed nose 23 (Fig. 4). A stop pin 24 secured to the slide 20 limits the range of rocking movement of the pivotal catch 22. The catch 22 is adapted for cooperation with a pin 25 which is arranged on a projection of the carrier arm 5 of the thread guide 6.

At the beginning of the winding operation the feed device is in the condition as shown in Fig. 6. By the reciprocating movement of the rod 1 the thread guide 6 is correspondingly moved, whereby the initial portion of the winding 27 is formed by the thread on the spool 26. After the initial portion of the winding 27 has reached the required diameter this winding portion contacts with the feeler member 10 in consequence whereof said member is turned and is accordingly advanced on the guide spindle 16. In this way the intermittent feeding of the thread guide 6 begins by the winding feeler member 10 moving the carrier arm 5 of the thread guide each time along with it. This is due to the winding feeler member 10 hitting a ring 5' which is provided on the carrier arm 5 and which, as shown in Fig. 4, has a vertical cross sectional form similar to a wedge, so that it enters into bearing engagement with the winding feeler member 10 only by means of a small surface portion. This surface portion is downwardly disposed relative to the guide spindle 16 and the winding feeler member 10, so that as the winding feeler member 10 hits the ring 5' on the carrier arm 5 of the thread guide 6 the thread 15 of the feeler carrier sleeve 12 is forced into engagement with the screw thread 17 of the guide spindle, due to the effect of reaction pressure, whereby the winding feeler member 10 is operatively engaged with the screw thread 17. This feeding operation of the thread guide 6 takes place provided that the resistance opposed by the compression spring 7 acting on the clamping sleeve 8 is overcome and thus the clamping mechanism constituted by the sleeve 3, the locking balls 9 and the clamping sleeve 8 is temporarily released, whereupon this mechanism holds the thread guide 6, after the latter has accomplished its feed step, in the new relative position of this guide to the rod 1.

When the winding on the spool has almost reached the required length and the winding feeler member 10 is thus located near the end of its traverse the slide 20 is advanced, that is, displaced in the direction away from the gear box 34 from a shaft 35 by means of a linkage 36, 37, 38. The shaft 35 performs one revolution.

In the course of this movement a projection 20' on the slide 20 meets with the pin 25 on the carrier arm 5 on the thread guide 6, whereupon the sleeve 12 carrying the feeler member 10 is pushed upward by means of an auxiliary lug meeting with a lower portion of the terminal cone 13 on the sleeve 12. The auxiliary lug 28 which is mounted on the carrier arm 5 of the thread guide 6 for rocking movement transversely to the guide spindle 16, against the influence of spring 28' (Fig. 3), eventually cooperates with an annular groove 13' in the feeler carrier sleeve 12. Due to the eccentric pressure which the auxiliary lug 28 exerts on the rear terminal cone 13 of the feeler carrier sleeve 12, which is maintained in engagement with the screw thread 17 of the guide spindle only by its own weight and that of winding feeler cone 10, the feeler carrier sleeve 12 is raised into such a position of inclination that the screw thread 15 of this sleeve is moved out of engagement with the screw thread 17, as shown in Fig. 5. At the same time the feeler carrier sleeve 12 bears with the inner rim 14 disposed at its front end on the guide spindle 16 from above.

Due to the screw thread 15 of the feeler carrier sleeve 12 moving out of engagement with the thread 17 of the guide spindle 16 the feed movement of the winding feeler member 10 is ceased and the winding on the spool is finished. The feeler carrier sleeve is then pushed back together with the winding feeler member 10 on the guide spindle 16 into initial position in the angular disposition which the sleeve has assumed. This is effected in the course of the return movement of the slide 20 by the action of the pivotal catch 22 which has moved into engagement with the pin 25 on the carrier arm 5 of the thread guide 6 in the course of the advance movement of the slide 20, as shown in Fig. 5.

Thereupon the ring 5' on the above-mentioned carrier arm 5 meets with the winding feeler member 10, whereupon the latter is returned together with said arm. As the slide 20 approaches the initial position the winding feeler member 10 hits a stop member 16' on the guide spindle 16, whereupon in the course of the further return movement of the slide 20 the auxiliary lug 28 is pushed out of engagement with the annular groove 13' of the feeler carrier sleeve 12 against spring-influence. Consequently, the feeler carrier sleeve falls back into normal position by the action of its own weight and the screw thread 15 on said sleeve enters into engagement with the screw thread 17 of the guide spindle 16. As the slide 20 in returning approaches the initial position the nose 23 on the pivotal catch 22 meets with a stop arm 29, as shown in Fig. 4, whereby the catch 22 is so rocked as to release the pin 25. The feed device is then in condition for beginning the winding of a fresh cop.

The modification shown in Fig. 10 differs from the embodiment of the invention hereinbefore described solely by the feature that the winding feeler member 10' of this modification is in the form of a disc being firmly connected to the screw sleeve 12 by means of a hub portion.

In the modification shown in Fig. 11 the thread guide 6 is mounted by means of its associated carrier arm 5 on a rod 39 which is partly inserted in a hollow rod 40 which during the operation of the machine is axially reciprocated from a traversing cam member 33 by means of a driving member 32. On the hollow rod 40 a compression spring 41 is pushed which abuts at one end on a set collar 42 and co-acts at the other end with a clamping sleeve 43 which is also pushed on the hollow rod 40. The clamping sleeve 43 cooperates in a similar manner as the clamping sleeve 8 described in connection with the previous examples with locking balls 44 by means of its conical inner surface around which the balls are distributed. Said balls are inserted in sockets in the hollow rod 40 and can be so pressed against the thread guide carrier rod 39 by the clamping sleeve 43 that this rod is locked to the hollow rod 40 for common movement. A stop

member 45 is axially adjustably connected with the gear box 34 by means of a screw 46.

When the hollow rod 40 is shifted in the direction for shifting the thread guide 6 in unison therewith towards the gear box 34, the winding feeler member 10 is approached on the winding 27 in progress of formation on the spool 26 in order that this winding may eventually come in contact with the member 10 whereby the latter is then advanced on the guide rod 16 for one feed step. At the same time the thread guide carrier rod 39 is advanced for one step relative to the hollow rod 40 by cooperation of the winding feeler member 10 with the thread guide 6.

To this end the clamping sleeve 42 must hit the stationary stop member 45 in order that this sleeve is pushed back against the influence of the compression spring 41 and consequently the pressure which the clamping sleeve 42 exerts on the locking balls 44 is compensated so that the thread guide carrier rod 39 is released for advancing for one feed step.

Thereupon the clamping sleeve 42 is moved in the direction towards the gear box 34, by influence of the compression spring 41, whilst the hollow rod 40 is moved in the direction opposite to that previously described, namely in the direction away from the gear box 34, whereby the clamping sleeve is brought into cooperation with the locking balls 44 again so as to exert an accordingly increased locking action on the rod 38 and thus on the thread guide 6 in the direction of feeding. This result is due to the fact that by a further minimum amount of displacement of the thread guide carrier rod 39 in the direction away from the gear box 34, the clamping action exerted by the locking balls 44 on the inside of the clamping sleeve 42 is enhanced commensurate with the play available between the locking balls 44 in their sockets in the hollow rod 40. On the other hand a relatively slight amount of displacement of the thread guide carrier rod 39 in the opposite direction has the effect of reducing the clamping action of the balls 44 and of completely compensating said action, due to cooperation of the clamping sleeve 42 with the stop member 45. The feeding of the thread guide 6 therefore takes place only as the locking action of the clamping sleeve 42 is completely compensated by said sleeve being thus rendered inoperative by the clamping sleeve meeting with the stationary stop member 45, that is, in mechanical fashion. The hollow rod 40 can be axially adjusted within the driving member 32 in which way the time moment at which the clamping mechanism is released by cooperation of the clamping sleeve 42 with the stop member 45 can be set in order to vary the extent to which the spring 44 is compressed and thereby to increase or decrease the amount of power required for this purpose in order that the winding to be produced on the spool becomes more or less hard to suit requirements. The same result is obtainable by axially re-adjusting the stop member 45.

The resistance opposed by the clamping sleeve 42 to the shifting of the thread guide 6 and thus to the rod 39 in the direction away from the gear box 34, can, however, also be overcome if sufficient power is exerted by a pivotal catch 22, as provided on the slide 20 in the first species of the feeding device.

In the different species of the feeding device hereinbefore described no stop frame is required for the winding feeler member. The winding feeler member runs smoothly on the guide spindle by virtue of which windings of perfect texture can be produced.

Alternatively, the guide spindle may be rotatably arranged on the machine in order to facilitate the disconnecting of the winding feeler member. Naturally the screw thread may be disposed in the bore of the screw sleeve or feeler carrier sleeve 12 also in another section of the sleeve than shown. In such an arrangement the point at which the thread guide meets with the respective stop member must be correspondingly chosen in order that the winding feeler member is each time properly locked to the screw thread of the guide spindle.

As shown in Fig. 12, the initial thread cone *b* has been formed on the spool 26 after the thread reserve *a* had been placed on the spool, due to cooperation of the feeler disc 10', which is firmly connected to a sleeve 12, with a guide roller 51. In the guide roller 51 a coil spring 52 is arranged (Fig. 15) which tends to force the balls 53 in the directions towards the respective head pieces 54 which are inserted in the ends of the roller 51 and have through-bores which are enlarged at their ends for the reception of the legs of a carrier stirrup 55. Due to the presence of the inner enlargements of the bores of the head pieces 54 bearing sockets are provided on the bores for the balls 53. The outer and inner enlargements of the bores thus formed permit the roller 51 to be disengaged from the carrier stirrup 55 by a corresponding slight axial displacing movement of the roller, thereby releasing the latter. This makes it possible, in a simple manner, to assemble this guide device and, if desired to inspect the same, and also to exchange the inner parts of the guide roller 51, and to remove said parts if not in use, without the necessity of employing an implement. The provision of mounting the guide roller 51 by means of the balls 53 ensures that the roller rotates unhindered.

The guide roller 51 is arranged on a plate 58 by means of the carrier stirrup 55 which plate partly underlies a holding plate 57 to which it is pivotally connected by means of a screw 59. A screw 59 screwed into the plate 58 protrudes through an arcuate slot 60 in the holding plate 57, which arrangement provided for adjusting the rockable plate 58 into a desired inclined position relative to the holding plate 57.

On the holding plate 57 a division is provided in accordance with which the rockable plate 58 can be adjusted with the aid of a point 58' arranged on this plate and permitting the position of adjustment of the rockable plate 58 and thus the angular position of the guide roller 51 to be read off immediately. The angular position of the guide roller 51 corresponds to the taper of the initial cone *b* of the winding in progress of formation on the spool 26. The length of the initial cone is determined by the time of cooperation of the guide spindle 16 carrying the winding feeler member 10 with the downwardly directed leg of the angular stop member 61, and can be varied by re-adjusting the member 61 by means of a set screw 62.

The spindle 16, being provided with screw threads on a portion of its circumference for interengagement with the screw bore of the carrier sleeve 12 for the feeler member 10 is mounted at its end removed from the machine casing (not shown) in a mounting 63. For this purpose a sleeve 64 is provided which is spring-pressed in the axial direction and guided by the mounting 63 so as to be movable in the transverse di-

rection to a certain extent, which adapts the spindle 16 to move transversely of the angular stop member 61 to a limited extent. The mounting 63 in turn is adjustable relative to a carrier bar 19'. The second end portion of the guide spindle 16 takes its bearing in a horizontal slot of a slot guide 65 which receives the depending leg of the stop member 61 and is adjustably arranged in a supporting member 66 transversely of the carrier bar 19'.

The winding feeler member 10 travels along the guide roller 51 until the guide spindle 16 hits the depending leg of the stop member 61 when the winding reaches its predetermined maximum thickness. Thereupon the winding feeler member is intermittently fed parallel to the axis of the spool to be wound in accordance with the position of the guide spindle 16, so that the cylindrical part of the winding is produced in the required length terminating in a front end cone. The guide roller 51 is adapted to rotate under the bearing pressure of the winding feeler member owing to which the thread is correspondingly less strained compared with the straining resulting from the use of an immovable guide rail for the winding feeler member.

The thread guide 6 is arranged on a stirrup 67 which is slidingly guided with both of its legs by a rod 1 projecting from the machine casing, one of the legs of the stirrup being in addition slidingly guided on a rod 68 whereby the stirrup 67 is secured against tilting. Between the two legs of the stirrup 67, which provides a driving member, the clamping mechanism 3, 7, 8, 9 is arranged on the rod 1, by the action of which the rod 1 is elastically coupled to the thread guide 6 for conjoint movement therewith, due to the presence of a spring 69 abutting against the stirrup 67.

One leg of the stirrup 67 is provided with a boss 70 which serves to cooperate with the feeler disc 10. For the purpose of initiating the feed step of the guide sleeve 3 the feeler disc 10 bears against the boss 70 on the stirrup 67, so that the clamping or feeding device is temporarily released while the resistance opposed by the compression spring 7 acting upon the locking sleeve 3 is overcome. On the completion of the feed step the clamping or feeding device holds the thread guide 6 in its new relative position to the rod 1 which is longitudinally reciprocated from the machine casing at a constant throw.

In order to produce the reserve winding the thread guide 6 is brought into the respective relative position to the spool to be wound by automatic means. Thereupon the cop winding proper is produced and then the machine is restored into the initial condition by automatic means.

I claim:

1. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a screw bore, a guide spindle having a screw thread for coupling engagement with said screw bore and supporting said feeler means at a circumferential point of said spindle longitudinally removed from said bore, and serving for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means arranged on said thread guide at a point situated oppositely to said feeler means supporting point relative to said spindle for locking said feeler means to said spindle by reaction effect due to intermittent engagement of said stop means with said feeler means, for initiating the feeding of said thread guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

2. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a screw bore, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, said screw bore having a clear diameter permitting said feeler means to be disengaged from said spindle screw thread by shifting said feeler means transversely to said spindle, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

3. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a screw bore, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, said screw bore having a clear diameter permitting said feeler means to be disengaged from said spindle screw thread by shifting said feeler means transversely to said spindle, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for uncoupling said feeler means from said screw thread at a point adjacent the end of traverse of said feeler means by moving the latter into an inclined position relative to said spindle, means for returning said feeler means into initial position, said uncoupling means releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

4. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of said feeler means so as to be moved thereby, said feeler means including a feeler carrier sleeve having a screw bore, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitational action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, said screw bore having a clear diameter permitting said feeler means to be disengaged from

said spindle screw thread by shifting said feeler means transversely to said spindle, an auxiliary member for disengaging said feeler means from said screw thread at a point adjacent the end of traverse of said feeler means by moving the latter into an inclined position relative to said spindle at a predetermined time by exerting eccentric pressure on said feeler carrier sleeve, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for returning said feeler means into initial position while disengaged from said screw thread, said auxiliary member releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

5. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of said feeler means so as to be moved thereby, said feeler means including a feeler carrier sleeve having a screw bore extending only over a section of the length of said sleeve, a guide spindle having a screw thread for being gravitatively coupled to said screw bore, having a diameter clearing said screw thread, for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, an auxiliary member for disengaging said feeler means from said screw thread at a point adjacent the end of traverse of said feeler means by inclining the latter by virtue of said bore clearance relative to said spindle at a predetermined time by exerting eccentric pressure on said feeler carrier sleeve, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for returning said feeler means into initial position while disengaged from said screw thread, said auxiliary member releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

6. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of said feeler means so as to be moved thereby, said feeler means including a feeler carrier sleeve having a screw bore and being provided with a cone, a guide spindle having a screw thread for being gravitatively coupled to said screw bore, having a diameter clearing said screw thread, for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, an auxiliary member for disengaging said feeler means from said screw thread at a point adjacent the end of traverse of said feeler means by inclining the latter by virtue of said bore clearance relative to said spindle at a predetermined time by exerting eccentric pressure on said feeler carrier sleeve, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for returning said feeler means into initial position while disengaged from said screw thread, said auxiliary member releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

7. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of said feeler means so as to be moved thereby, said feeler means including a feeler carrier sleeve having a screw bore, and being provided with a cone having an annular groove, a guide spindle having a screw thread for being gravitatively coupled to said screw bore, having a diameter clearing said screw thread, for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, an auxiliary member for disengaging said feeler means from said screw thread at a point adjacent the end of the traverse of said feeler means by inclining the latter by virtue of said bore clearance relative to said spindle at a predetermined time by exerting eccentric pressure on said feeler carrier sleeve by interengagement with said groove, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for returning said feeler means along said spindle into initial position with said auxiliary member engaged with said groove, said auxiliary member releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

8. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of said feeler means so as to be moved thereby, said feeler means including a feeler carrier sleeve having a screw bore and being provided with a cone, a guide spindle having a screw thread for being gravitatively coupled to said screw bore, having a diameter clearing said screw thread, for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, an auxiliary spring-influenced arm rockably mounted on a carrier arm for said thread guide for disengaging said feeler means from said screw thread at a point adjacent the end of traverse of said feeler means by inclining the latter by virtue of said bore clearance relative to said spindle at a predetermined time by exerting eccentric pressure on said feeler carrier sleeve, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for returning said feeler means into initial position while disengaged from said screw thread, said auxiliary arm releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

9. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of said feeler means so as to be moved thereby, said feeler means including a feeler carrier sleeve having a screw bore and a winding feeler member, means for adjusting said winding feeler member axially of said carrier sleeve, a guide spindle having a screw thread for being gravitatively coupled to said screw bore, having a diameter clearing said screw thread, for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, an auxiliary member for disengaging said feeler means from said screw

thread at a point adjacent the end of traverse of said feeler means by inclining the latter by virtue of said bore clearance relative to said spindle at a predetermined time by exerting eccentric pressure on said feeler carrier sleeve, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, means for returning said feeler means into initial position while disengaged from said screw thread, said auxiliary member releasing said feeler means, when returned, and means for coupling said released feeler means with said screw thread again.

10. In a cop winding machine, a spool for receiving a cop winding, a carrier rod, a thread guide arranged on said carrier rod, an axially reciprocatory hollow rod receiving said carrier rod in its hollow bore, a clamping mechanism for temporarily establishing driving engagement between said hollow rod and said thread guide carrier rod for intermittently feeding said thread guide, a winding feeler means having a screw bore, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

11. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a winding feeler member and a screw bore, a linear guide constituted by a rotatably mounted guide roller for intermittent cooperation with said winding feeler member, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

12. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a winding feeler member and a screw bore, a linear guide constituted by a rotatably mounted guide roller for intermittent cooperation with said winding feeler member, carrier legs for said guide roller slidingly engaging with the ends of said guide roller, the latter being removable from said carrier legs by accordingly shifting said roller in the axial direction, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

13. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a winding feeler member and a screw bore, a linear guide constituted by a rotatably mounted guide roller for intermittent cooperation with said winding feeler member, head pieces having through-bores with enlarged ends provided in the end portions of said guide roller, carrier legs for said guide roller slidingly engaging with said through-bores of said head pieces in said guide roller, the latter being removable from said carrier legs by accordingly shifting said roller in the axial direction, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

14. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a winding feeler member and a screw bore, a linear guide constituted by a rotatably mounted guide roller for intermittent cooperation with said winding feeler member, head pieces having through-bores with their inner ends formed as bearing sockets for bearing engagement with spring-pressed carrier legs for said guide roller slidingly engaging with said through-bores of said head pieces in said guide roller, the latter being removable from said carrier legs by accordingly shifting said roller in the axial direction, a guide spindle having a screw thread for coupling engagement with said screw bore, by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

15. In a cop winding machine, a spool for receiving a cop winding, a winding feeler means

slidably mounted to move forwardly as the winding progresses, a reciprocatory thread guide extending into the path of the feeler means so as to be moved thereby, said feeler means having a winding feeler member and a screw bore, a linear guide constituted by a rotatably mounted guide roller for intermittent cooperation with said winding feeler member, a rockable plate carrying said guide roller, a holding plate for said rockable plate, means for adjusting the angular position of said rockable plate relative to said holding plate, carrier legs for said guide roller slidingly engaging with the ends of said guide roller, the latter being removable from said carrier legs by accordingly shifting said roller in the axial direction, a guide spindle having a screw thread for coupling engagement with said screw bore by gravitative action of said feeler means for intermittently feeding said feeler means along said screw thread in dependence upon the cop building operation, stop means associated with said thread guide for intermittent engagement with said feeler means for initiating the feeding of said guide by said feeler means, and means for uncoupling said feeler means from said screw thread on the termination of said cop winding and for returning said feeler means into initial position as well as for coupling said feeler means with said screw thread again.

WALTER SIEGENTHALER.